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In re Application of:

SUZUKI et al.

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For: PERIODIC CONTROL SYNCHRONOUS SYSTEM

SPECIFICATION, CLAIMS AND ABSTRACT AS PRELIMINARILY AMENDED

Amendments to the paragraph beginning at page 1, line 4:

The present invention relates to a period control synchronous system for synchronizing periodic control between one or more controllers connected to a network and one or more devices such as servo motors, connected to the network.

Amendments to the paragraph beginning at page 1, line 11:

Conventionally, as ~~the~~ a network system for servo motors, for example, ~~the~~ a system using the SERCOS interface (IEEE1491) has been known. This SERCOS interface is designed, as shown in Fig. 23, to synchronize the periodic operation of servo drive by transmitting a synchronous packet (sync-telegram) to the servo drive by using the interface in every control period of periodic control.

Amendments to the paragraph beginning at page 1, line 23:

However, in the conventional system using the SERCOS interface, the precision of the control period is determined by the precision of periodic transmission of the synchronous packet (sync-telegram), and if transfer of a large packet is attempted ~~to perform packet transfer of large size and~~ at the same time as asynchronous communication between slaves ~~at the same time~~, jitter occurs in the transmission period

of the synchronous packet (sync-telegram), and packet transfer of large size or asynchronous communication between slaves cannot be ~~done, and it lacks in~~ achieved. Thus, flexibility is lacking.

Amendments to the paragraph beginning at page 16, line 23:
Fig. 1 is a block diagram of outline of ~~configuration of~~ a periodic control synchronous system in a first embodiment of the invention;

Amendments to the paragraph beginning at page 17, line 4:
Fig. 3 is a block diagram of ~~configuration of~~ a periodic control synchronous system in a second embodiment of the invention;

Amendments to the paragraph beginning at page 17, line 7:
Fig. 4 is a timing chart showing timer correction ~~process~~ when the period of the control period timer or the operation period timer shown in Fig. 3 is longer than the period of periodic control;

Amendments to the paragraph beginning at page 17, line 11:
Fig. 5 is a timing chart showing timer correction ~~process~~ when the period of the control period timer or the operation period timer shown in Fig. 3 is shorter than the period of periodic control;

Amendments to the paragraph beginning at page 17, line 15:
Fig. 6 is a timing chart showing ~~other~~ another timer correction ~~process~~ when the period of the control period timer or the operation period timer shown in Fig. 3 is shorter than the period of periodic control;

Amendments to the paragraph beginning at page 17, line 19:
Fig. 7 is a timing chart showing timer period correction ~~process~~ when the period of the control period timer or the operation period timer shown in Fig. 3 is longer than the period of periodic control;

Amendments to the paragraph beginning at page 17, line 23:

Fig. 8 is a timing chart showing timer period correction ~~process~~ when the period of the control period timer or the operation period timer shown in Fig. 3 is shorter than the period of periodic control;

Amendments to the paragraph beginning at page 18, line 2:

Fig. 9 is a block diagram of ~~configuration of~~ a periodic control synchronous system in a third embodiment of the invention;

Amendments to the paragraph beginning at page 18, line 5:

Fig. 10 is a timing chart showing synchronous a process of local sync timing using a time stamp;

Amendments to the paragraph beginning at page 18, line 7:

Fig. 11 is a timing chart showing timer correction ~~process~~ when the period of the operation period timer shown in Fig. 10 is longer than the control period;

Amendments to the paragraph beginning at page 18, line 10:

Fig. 12 is a timing chart showing timer correction ~~process~~ when the period of the operation period timer shown in Fig. 10 is shorter than the control period;

Amendments to the paragraph beginning at page 18, line 13:

Fig. 13 is a timing chart showing ~~other~~ another timer correction ~~process~~ when the period of the operation period timer shown in Fig. 10 is shorter than the control period;

Amendments to the paragraph beginning at page 18, line 16:

Fig. 14 is a timing chart showing timer period correction ~~process~~ when the period of the control period timer or the operation period timer shown in Fig. 10 is longer than the period of periodic control;

Amendments to the paragraph beginning at page 18, line 20:

Fig. 15 is a timing chart showing timer period correction ~~process~~ when the period of the control period timer the or operation period timer shown in Fig. 10 is shorter than the period of periodic control;

Amendments to the paragraph beginning at page 18, line 24:

Fig. 16 is a block diagram of ~~configuration of~~ a periodic control synchronous system in a fourth embodiment of the invention;

Amendments to the paragraph beginning at page 19, line 2:

Fig. 17 is a timing chart showing a synchronous process of system sync timing using time stamp;

Amendments to the paragraph beginning at page 19, line 4:

Fig. 18 is a timing chart showing a synchronous process when the system sync timing is ahead of the local sync timing;

Amendments to the paragraph beginning at page 19, line 6:

Fig. 19 is a timing chart showing synchronous a process when the local sync timing is ahead of the system sync timing;

Amendments to the paragraph beginning at page 19, line 8:

Fig. 20 is a timing chart showing timer period correction ~~process~~;

Amendments to the paragraph beginning at page 19, line 10:

Fig. 21 is a block diagram of ~~configuration of~~ a periodic control synchronous system in a fifth embodiment of the invention;

Amendments to the paragraph beginning at page 19, line 13:

Fig. 22 is a timing chart showing a synchronous process of multi-system periodic control using time stamp; and

Amendments to the paragraph beginning at page 19, line 15:

Fig. 23 is a diagram showing ~~configuration of~~ a conventional periodic control synchronous system using a SERCOS interface.

Amendments to existing claims:

1. (Amended) A periodic control synchronous system for synchronizing periodic control between ~~one or more~~ controllers connected ~~to~~ in a network and ~~one or more~~ devices connected to said network, wherein

each of said ~~controller~~ controllers and ~~device comprise~~ said devices comprises a global timer ~~which is~~ controlled through said network, and

synchronization of periodic control is performed by generating synchronous timing for periodic control ~~by~~ using ~~the~~ global time indicated by said global timer.

2. (Amended) The periodic control synchronous system according to claim 1, wherein

each of said global ~~timer~~ timers of said ~~controller~~ controllers is set ~~at~~ by a master global timer,

each of said global ~~timer~~ timers of said ~~device~~ devices is set ~~at~~ by a slave global timer,

each of said ~~controller~~ controllers comprises a transmitting unit which transmits ~~the~~ a periodic timing time using ~~the~~ global time indicated by the master global timer to said ~~device~~ devices as a period transfer packet, and

each of said ~~device~~ devices comprises a periodic control unit which performs periodic control ~~by~~ using the synchronous timing time of the periodic transfer packet transmitted by said transmitting unit and the global time indicated by said slave global timer.

3. (Amended) The periodic control synchronous system according to claim 1, wherein each of said ~~device~~ devices further includes,

an operation period timer which controls ~~said~~ an operation period of said device itself; and

a correcting unit which corrects said operation period timer by determining the time difference between the global time indicated by said global timer of said device and the synchronous timing time ~~indicted~~ indicated by said controller at the synchronous timing indicated by said operation period timer, and determines ~~the~~ a timer correction value or a timer period correction value of said operation period timer based on ~~the basis of~~ the ~~obtained~~ time difference.

4. (Amended) The periodic control synchronous system according to claim 3, wherein said correcting unit includes,

a detecting unit which detects whether the time difference is within ~~a specified~~ an allowable range ~~or not~~, and

~~controls to correct~~ corrects said operation period timer based on ~~the basis of~~ the timer correction value or the timer period correction value when the time difference is within ~~the specified~~ an allowable range, and does not ~~to~~ correct said operation period timer when the time difference is ~~out~~ outside of the ~~specified~~ allowable range.

5. (Amended) The periodic control synchronous system according to claim 1, wherein each of said ~~controller~~ controllers further includes,

a control period timer which controls ~~the~~ an control period of said controller itself; and

a correcting unit which corrects said control period timer by determining ~~the~~ time difference between the global time indicated by said global timer of said controller and the synchronous timing time ~~indicted~~ indicated by said controller at the synchronous timing indicated by said control period timer, and determines ~~the~~ a timer correction value or timer period correction value of said control period timer based on ~~the basis of~~ the ~~obtained~~ time difference.

6. (Amended) The periodic control synchronous system according to claim 5, wherein said correcting unit includes,

a detecting unit which detects whether the time difference is within a specified allowable range ~~or not~~, and

~~controls to correct~~corrects said control period timer based on ~~the basis of~~ the timer correction value or the timer period correction value when the time difference is within ~~the specified~~ allowable range, and does not ~~to~~ correct said control period timer when the time difference is ~~out~~ outside of the ~~specified~~ allowable range.

7. (Amended) A periodic control synchronous system for synchronizing periodic control between ~~one or more~~ controllers connected ~~to~~ in a network and ~~one or more~~ devices connected to said network, wherein

each of said ~~controller~~ controllers includes,

a first global timer ~~which is~~ controlled through said network;

a control period timer which controls ~~the~~ a control period of periodic control;

a time stamp providing unit which provides ~~the~~ a periodic transfer packet with ~~the~~ a time stamp showing ~~the~~ synchronous timing of the ~~period~~ control period designated by said control period timer by using ~~the~~ global time indicated by said first global timer; and

a transmitting unit which transmits the periodic transfer packet provided with the time stamp to said ~~device~~ devices, and

each of said ~~device~~ devices includes,

a second global timer ~~which is~~ controlled through said network; and

a periodic control unit which synchronizes ~~said~~ an operation period of said device with the control period ~~by~~ using the synchronous timing time of the periodic control indicated by the time stamp of the periodic transfer packet transmitted by said transmitting unit and ~~the~~ global time indicated by said second global timer.

8. (Amended) The periodic control synchronous system according to claim 7, wherein

said controller comprises a latch unit which latches the global time of said first global timer, and holds the ~~latched~~ time latched,

said control period timer latches the global time of said first global timer in said latch unit at the synchronous timing of the periodic control designated by said control period timer, and

said time stamp providing unit provides the periodic transfer packet with the time stamp having the global time latched by said latch unit, offset by ~~the~~ a portion of the control period.

9. (Amended) The periodic control synchronous system according to claim 7, wherein each of said ~~device~~ devices includes,

an operation control period timer which controls ~~said~~ the operation period of said device itself;

a comparing unit which compares the synchronous timing time of the periodic control indicated by the time stamp of the periodic transfer packet transmitted by said transmitting unit and the global time indicated by said second global timer; and

a correcting unit which corrects said operation period timer by determining ~~the~~ time difference between the synchronous timing time of the periodic control indicated by the time stamp compared by said comparing unit and the global time indicated by said second global timer at the synchronous timing indicated by said operation period timer, and determines ~~the~~ a timer correction value or a timer period correction value of said operation period timer based on ~~the basis of~~ the ~~obtained~~ time difference.

10. (Amended) The periodic control synchronous system according to claim 9, wherein said correcting unit includes,

a detecting unit which detects whether the time difference is within ~~a specified~~ an allowable range ~~or not~~; and

~~controls to correct~~corrects said operation period timer based on ~~the basis of~~ the timer correction value or the timer period correction value when the time difference is within the ~~specified~~ allowable range, and does not ~~to~~ correct said operation period timer when the time difference is ~~out~~ outside of the ~~specified~~ allowable range.

11. (Amended) The periodic control synchronous system according to claim 7, wherein each of said ~~device~~ devices includes,

an operation control period timer which controls ~~said~~ an operation period of said device itself;

a comparing unit which compares the synchronous timing time of the periodic control indicated by the time stamp of the periodic transfer packet transmitted by said transmitting unit and the global time indicated by said second global timer; and

a correcting unit which resets said operation period timer when the global time indicated by said second global timer reaches the synchronous timing time of the periodic control indicated by the time stamp.

12. (Amended) The periodic control synchronous system according to claim 11, wherein said correcting unit resets said operation period timer when reaching the synchronous timing indicated by said operation period timer before the global time indicated by said second global timer reaches the synchronous timing time of the periodic control indicated by the time stamp, and resets said operation period timer again later when the synchronous timing time of the periodic control indicated by the time stamp at least reaches ~~or exceeds~~ the global time indicated by said second global timer.

13. (Amended) The periodic control synchronous system according to claim 11, wherein said correcting unit includes,

a detecting unit which detects whether the time difference between the synchronous timing time of the periodic control indicated by the time stamp compared by said comparing unit and the global time indicated by said second global timer at the synchronous timing indicated by said operation period timer is within ~~a specified~~ an allowable range ~~or not~~, and

~~controls~~ does not ~~to~~ correct said operation period timer when the time difference is ~~out~~ outside of the ~~specified~~ allowable range.

14. (Amended) The periodic control synchronous system according to claim 11, wherein said correcting unit determines the timer periodic correction value of said

operation period timer by finding ~~the~~ a value of said operation period timer at the synchronous timing of the periodic control indicated by the time stamp, or determines the timer periodic correction value of said operation period timer from the time difference between the synchronous timing time of the periodic control indicated by the time stamp and the global time indicated by said second global timer, and thereby corrects said operation period timer based on ~~the basis of the obtained~~ timer periodic correction value.

15. (Amended) A periodic control synchronous system for synchronizing periodic control between controllers connected to first and second networks, and ~~one or more~~ devices connected to said first network ~~one or more~~ and devices connected to said second network, wherein

each of said ~~controller~~ controllers includes,

a first global timer controlled through said first network;

a second global timer controlled through said second network;

a control period timer which controls ~~the~~ a control period of periodic control of said periodic control synchronous system;

a time stamp providing unit which provides ~~the~~ a periodic transfer packet transmitted periodically to said first and second networks with the time stamp showing ~~the~~ synchronous timing of the ~~period~~ control period designated by said control period timer ~~by~~ using ~~the~~ global time indicated by said first and second global timers;

a first transmitting unit which transmits the periodic transfer packet provided with the time stamp to at least one ~~or more~~ of said devices connected to ~~the corresponding~~ said first network; and

a second transmitting unit which transmits the periodic transfer packet provided with the time stamp to at least one ~~or more~~ of said devices connected to ~~the corresponding~~ said second network, and

each ~~one~~ of ~~one or more~~ said devices connected to said first and second networks ~~include~~ includes,

a third global timer controlled respectively through said first and second networks; and

a periodic control unit which synchronizes ~~said~~ an operation period of the corresponding device with the control period ~~by~~ using the synchronous timing time of the periodic control indicated by the time stamp of the periodic transfer packet transmitted by said first and second transmitting units and ~~the~~ global time indicated by said third global timer.

16. (Amended) The periodic control synchronous system according to claim 15, wherein said controller includes,

a first latch unit which latches the global time of said first global timer, and holds the ~~latched~~ time latched; and

a second latch unit which latches ~~the~~ global time of said second global timer, and holds the ~~latched~~ time latched, wherein

said control period timer latches the global time of said first and second global timers in said first and second latch ~~unit~~ units at the synchronous timing of the periodic control designated by said control period timer, and

said time stamp providing unit provides the periodic transfer packet with the time stamp having the global time latched by said first and second latch units offset by ~~the~~ a portion of the control period.

Amendments to the abstract:

ABSTRACT OF THE DISCLOSURE

A controller controls a time stamp providing unit to provide a periodic transfer packet with a time stamp showing the synchronous timing of periodic control designated by ~~said~~ the control period timer using the global time indicated by a global timer. Devices ~~correct~~ are corrected to synchronize operation period timers with the periodic control, by using the time difference between the synchronous timing time of periodic control indicated by the time stamp of the transmitted periodic transfer packet and the global time indicated by global timers, at ~~the~~ periodic operation timing of ~~said~~ the operation period timers.